

The Knowledge Bank at The Ohio State University

Ohio State Engineer

Title: The Baby Metal

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Issue Date: 1944-11

Publisher: Ohio State University, College of Engineering

Citation: Ohio State Engineer, vol. 28, no. 1 (November, 1944), 11-12, 20, 24.

URI: <http://hdl.handle.net/1811/36108>

THE BABY METAL

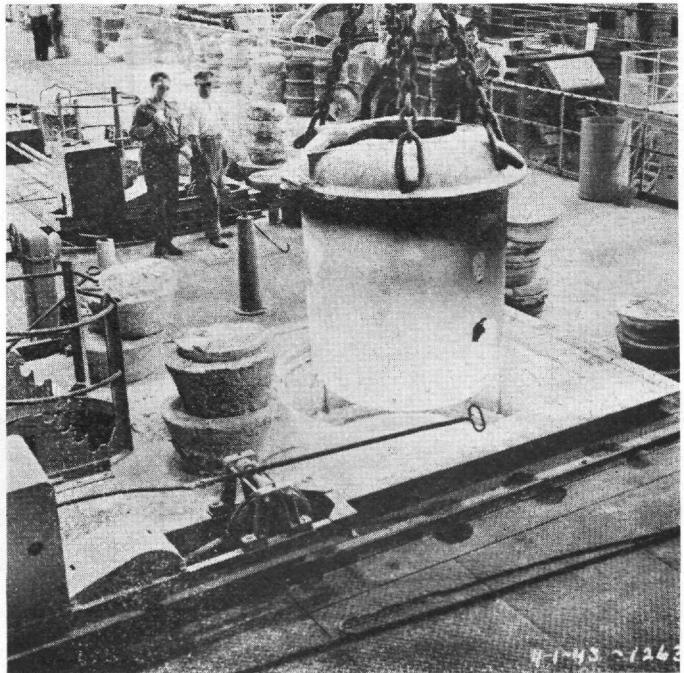
By ERNEST C. GRABILL, Ch E III

"MAGNESIUM? What would I do with magnesium? No, thank you, no magnesium today." Yes, that was the attitude of the average manufacturer before the war. As late as 1941, industry sneered at magnesium. The Dow Chemical Corporation, which was the entire magnesium industry until 1941, watched its pitiful little 2500 tons pile up expensively in warehouses, lying like a deadweight on the market. But a remarkable change, you might even call it a miracle, took place when the Allies discovered how the Nazis could carry such heavy bomb loads in their airplanes. The cry for magnesium became deafening. Dow doubled and doubled again its capacities for producing magnesium. Henry J. Kaiser went after the magnesium production problem in his characteristic way. The government has constructed 14 plants and now our magnesium production (estimated) has risen from 2500 tons to 250,000 tons per year. The government plant investment alone totals some 370 million dollars. What does the manufacturer say now about magnesium? "Magnesium? Well, perhaps I can use some magnesium in this thing or that thing after the war, but I don't really know." That's the real answer. We don't **know** what magnesium is good for other than for airplanes and incendiary bombs, and these markets will almost vanish when peace returns. Some people envision a new light-alloy age featuring the three lightweights, beryllium, magnesium, and aluminum, with extremely light planes, automobiles and other machines. At the other extreme, some people see a new, enlarged steel age, with new improvements in the fabrication and use of steel. But as yet, this problem of magnesium's future has no solution.

However, let us enumerate some of the present uses for magnesium. Perhaps we can garner some information which may throw light on the future.

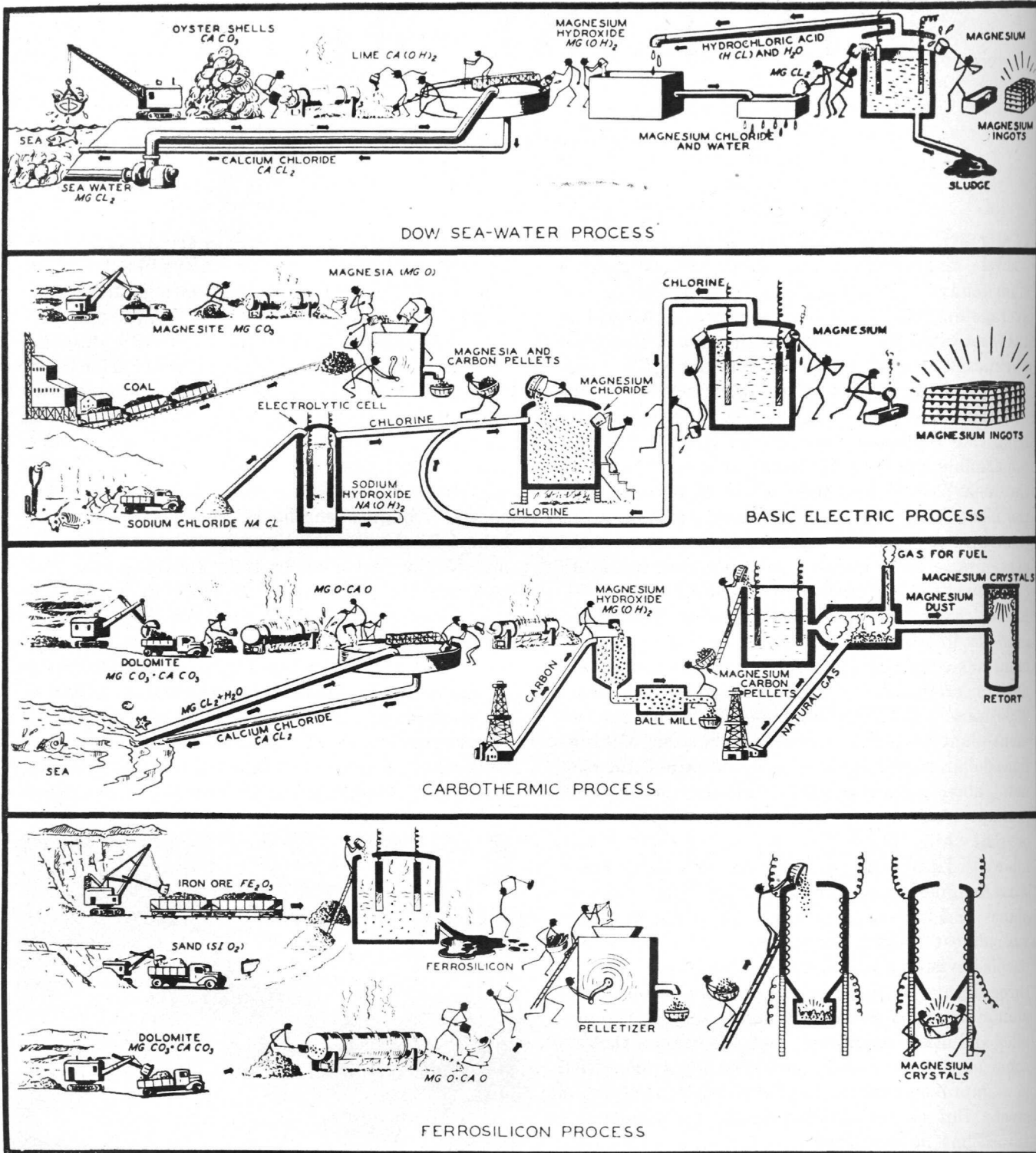
Every bomber and fighter plane has, on the average, at least one-half ton of magnesium which is used in a wide variety of ways; castings, extrusions, forgings, and sheet all the way from the tail assembly to the nose. In the engines, most main housing castings are magnesium. Throughout the air frame literally hundreds of parts, from

rudder pedals to wing brackets are made of magnesium. Practically every instrument is constructed partly of magnesium castings and extrusions. The main structures of machine gun turrets are made of magnesium sheets and castings. Almost every type of military aircraft from large four-engined bombers to small training planes uses magnesium wheels. Magnesium is also being used in the actual structure of the air frames, and the new Douglas cargo planes use 6-inch magnesium I-beams for floor construction. Recently, Douglas engineers reported that these beams were 5 per cent lighter, 25 per cent stronger and 35 per cent cheaper than anything they had used before. In some of the more advanced combat planes, magnesium is used for ailerons, trailing edge surfaces, interior duct work, paneling and doors. In planning for the fighting planes of the future, aeronautical engineers are planning on some models to use magnesium almost entirely throughout the constituent. These statistics would seem to indicate magnesium's practicability, but the great demand for airplanes will cease when



—Courtesy Westinghouse.

Magnesium "cheeses" and a two-ton alloying furnace at the Basic Magnesium plant



—Courtesy Westinghouse.

the war is ended, so let's go on. The War Department selected magnesium for one of its newer "secret weapons." The so-called "Goop Bomb" is a block-burner composed essentially of powdered magnesium. In all industrial operations where portability is an important consideration, magnesium offers exceptional advantages. Before the war, a large number of portable conveyors for use in railway express terminals were constructed. A few test ones were made of magnesium, and it

was found that the use of magnesium reduced the weight by over 50 per cent. That is a big reduction, and here is a tested use for magnesium. Until the war curtailed the use of magnesium, over 20,000 feet of these conveyors were installed in various terminals. As for fabrication, it is known that magnesium can be spot welded, arc welded, and gas welded. One recent development is helium arc welding which employs no welding

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MAGNESIUM

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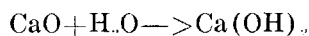
flux, and overcomes disadvantages encountered with other types of weld. There is food for thought in these statistics.

Now add to the data above the fact that magnesium is the third most abundant of the engineering metals in the earth's crust (2.24 per cent). But don't stop here. One cubic mile of ocean water contains about 23 million tons of magnesium, which is quite some reserve! That brings us around to the question, "How is magnesium, as such, obtained?"

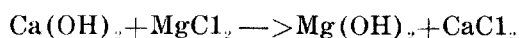
There are four main classifications: (1) Dow process of electrolytic reduction of magnesium chloride from sea water; (2) electrolytic reduction of magnesium chloride from various ores; (3) ferro-silicon process; and (4) the Hansgirk process. There is very great rivalry among these four technologies but no sales or price competition because all that is produced is bought and the price is fixed by the government, but there is a race to cut production costs.

Taking the Dow Process first, it should be noted that despite the nice figure of 23 million tons of magnesium per cubic mile of sea water, this reduces to 0.01 pound per gallon! The raw materials are oyster shells, ocean water, natural gas, salt, chlorine and hydrochloric acid. The oyster shells furnish the lime, the ocean water the magnesium chloride, the natural gas the power, the salt produces caustic soda, and the chlorine makes the hydrochloric acid which is used in the process. Briefly, here is the process:

300 million gallons of sea water are pumped in at the rate of 248 thousand gallons per minute. There is a preliminary coarse screening in rotary screens to prevent trash greater than six mesh in size from entering. Then there is a second pumping and cleaning. Lime is obtained from the oyster shells. These are washed in a rotary screen and stored. Then the clean shells are calcined in a 300 foot rotary kiln, eight feet in diameter. The calcium oxide is slaked into a slurry form in a rotary slaker (seven feet, nine inches in diameter). This reaction takes place:

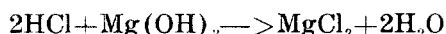


This is thickened in a Dorr thickener. In flocculators, lime is added to weak magnesium chloride (sea water) and magnesium hydroxide precipitates out. The particle size of the precipitated substance is less than a micron in size, and this is what the engineers had to contend with. Here is the reaction:

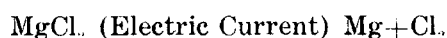


The lime is fed in on the sides and the sea water

at the ends of the flocculators. The magnesium hydroxide suspension in sea water enters a battery of four Dorr tanks in parallel where it settles and thickens. The underflow sludge from the thickeners is filtered in a battery of Morre leaf filters. Most of the sea water is now removed. The filter cake is neutralized with hydrochloric acid:



The still relatively dilute solution is evaporated in direct gas fired spray evaporators. Sodium chloride and calcium sulfate are filtered out and then the final dehydration of the magnesium chloride takes place in huge shelf driers. The product is taken to the electrolytic cells, where this reaction takes place producing pure magnesium:

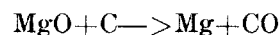


It is then cast in 17-pound pigs. The chlorine goes to hydrochloric acid burners and goes through absorbers to produce the hydrochloric acid which is then used in the process.

The second method usually entails conversion of the magnesium ore to magnesium chloride and this is then electrolysed from a fused bath.

The third method, the "ferro-silicon" process, is still a rather secret process, but we do know the general things which happen. Dolomite ($\text{CaCO}_3 \cdot \text{MgCO}_3$) is the raw material. A combination of dolomite and ferro-silicon properly proportioned at high vacuum and high temperature causes the magnesium to be driven off as a vapor. Coming into contact with a cool surface, this condenses, while the iron rides along "on the coat-tails" of the silicon.

The Hansgirk process is the one which Henry J. Kaiser uses in his plants. This process was first successfully used at a pilot plant in Austria in 1935, but was abandoned in 1939 because of an explosion. Kaiser's engineers solved the problem and got rid of the bugs. This method depends primarily upon the reduction of magnesium, using finely divided carbon as the reducing agent. The equation is:



However, it is not so simple as it looks. The reaction does not take place except at temperatures of 2000 to 2100° centigrade, and unless the products are cooled suddenly, the reaction reverses itself and you end up with the reactants. Magnesia briquettes are fed into a reduction furnace where the reaction takes place. The products are drawn off and immediately chilled by a blast of natural gas. The dust thus obtained contains 60

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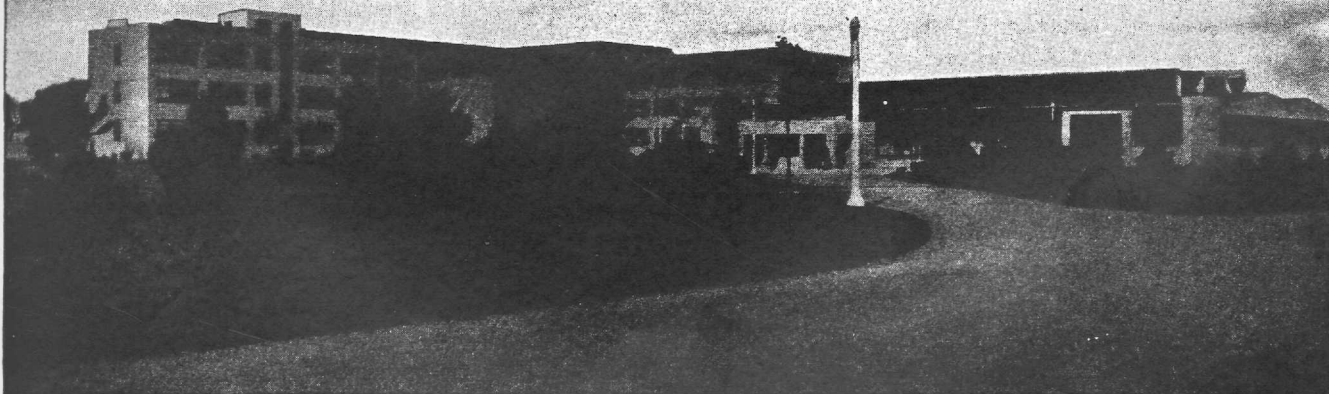
New RCA Penicillin Process Speeds Production!

TODAY, when the wonder-drug penicillin is so vitally needed on the fighting fronts and in the home-front sickrooms, the Radio Corporation of America reveals that a revolutionary method of production has been perfected in RCA Laboratories.

Tests at the Squibb Penicillin production center at New Brunswick, N. J., show that a single RCA electronic installation can concentrate two billion Oxford units of Penicillin in 24 hours—enough to administer 100,000 individual doses.

Besides streamlining the elaborate evaporation method, the new RCA Electronic system includes these important advantages: reduction of operation costs, lowered maintenance costs, less possibility of mechanical difficulties and production delays, great savings in floor space, and impressive reduction in initial equipment costs.

The new RCA electronic dehydrator of penicillin is shown here in regular operation at the plant of E. R. Squibb & Sons.



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MAGNESIUM

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to 70 per cent metallic magnesium. This dust is compressed into tablets and charged into electrically heated retorts at high vacuum at about 750°C. The magnesium vapors rise to the top and condense on the steel walls which are cooled by water and oil. This magnesium is then remelted in regular furnaces and cast into ingots of 99.97 per cent purity.

There are the four main processes. The electrolytic methods produce about 70 per cent, ferro-silicon process about 20 per cent, the Hansgirg process about 7 per cent, and the other remaining 3 per cent by semi-experimental methods.

One of the greatest bottlenecks in the use of magnesium was its tendency to corrode, but now by alloying minor amounts of other metals (usually less than 5 per cent) magnesium is practically immune to weathering and corrosion due to other effects is reduced markedly. Anodizing treatment produces a highly resistant surface film on the magnesium which meets any ordinary requirements, and can be restored by paints and lacquers when necessary.

The future of the so-called "Light Metal Age" now is in the hands of the metallurgists who have barely scratched the surface as yet of the metallurgy of the light metals. The future of magnesium looks bright, for it is more economical to produce than aluminum, lighter than aluminum, and is strong enough to have an unprecedented use in construction.
